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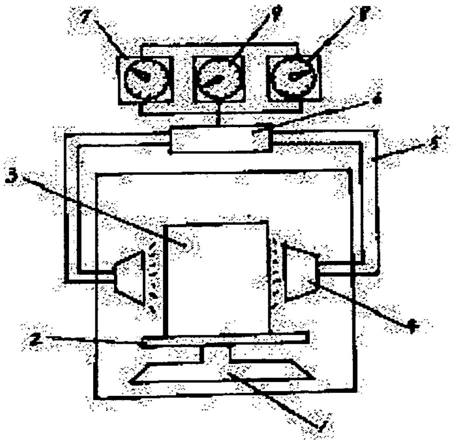
(54) HEATRONIC PREHEATING METHOD

(57)Abstract:

PURPOSE: To avoid a risk of overvulcanization and perform suitable vulcanization, by heateronically heating an unvulcanized product intermittently within a temperature range not inducing vulcanization until the unvulcanized product reaches a prescribed preheating temperature.

CONSTITUTION: In a heating chamber 1 is arranged a turntable 2 rotatable during heating on which a raw tire 3 is put with its axis vertically aligned, and adjacent to both sides of the raw tire 3 are positioned UHF radiation horns 4, 4' that are communicated through waveguides 5 with a UHF generator 6. To the generator 6 are connected the first fimer 7, the second timer 8, and the third timer 9 for controlling intermittent radiation, and the timers, after their respective set periods have expired, are interacted serially by limit switches. Period for the intermittent radiation is preferably selected to be a period necessary to elevate a temperature in the chamber 1 to slightly below 100°C.



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Specification

1. Title of the invention

HIGH-FREQUENCY PREHEATING METHOD

2. Claim

The high-frequency preheating method where non-vulcanized rubber products are preheated by radiating high-frequency wave, characterized in that the non-vulcanized rubber products are kept intermittently heated within such temperature range as not being vulcanized until the temperature thereof reaches a predetermined preheating temperature.

3. Detailed Description of the Invention

This invention relates to the improvement of a method for preheating non-vulcanized rubber products, especially such green tires as pneumatic tires, track shoe tires, solid tires to a predetermined temperature by such high-frequency wave as micro-wave, UHF etc., before vulcanizing them in a vulcanizer.

Conventionally, in vulcanizing operation of non-vulcanized rubber products which have a bulky part with big heat capacity such as green tires, preheating operation to preheat the non-vulcanized rubber products to the predetermined temperature before vulcanization is generally adopted due to the inconvenience that when the product is heated in high temperature in order to vulcanize the central part of the bulky part, the outer surface part of the product is over-vulcanized till the central part reaches an optimally vulcanized condition, and the consumption of excessive amount of heat energy. Comparing to a preheating method by continuous radiation of infrared rays or the like (conduction heating), a preheating method by continuous radiation of high-frequency wave such as UHF (induction heating) has such merits that firstly the central part e.g. inner part of tread which is most difficult to be heated, in other words, is most lately vulcanized in case of conduction heating, is first to be increased in temperature and preheated and is therefore most desirably optimally vulcanized, and that secondly the reduction of total time for vulcanization is possible owing to comparatively short time to reach the predetermined preheat temperature. However, this method has defects as follows: the temperature of the product increases rapidly up to the predetermined value by continuous heat radiation but heat quantity input is so insufficient owing to low heat conductivity of rubber that an enough preheating effect cannot be obtained comparing to apparent temperature, and even if thermal radiation from the product is suppressed after preheating, the actual internal temperature of the tire T_2 at the starting point of vulcanization is below the apparent temperature T_1 at the finishing point of preheating as illustrated with a dotted line in Fig. 1, therefore performing vulcanization only for standard time interval causes quality defect of insufficient vulcanization, and if the continuous radiation time is simply prolonged in order to cover the insufficiency of heat input, the internal temperature of the tire is so over-increased resulting in so-called over-vulcanized condition where rubber is partially burned, and an ideal tire can not be obtained.

The present invention aims at providing such high-frequency preheating method dissolving the above-mentioned defects of the prior art where the same preheating effect as the apparent preheated temperature without a danger of over-vulcanization can be obtained so that vulcanization in the successive process can be optimally kept. The method is characterized in that when non-vulcanized rubber products are preheated by radiating high-frequency wave, the non-vulcanized rubber products are kept intermittently heated within such temperature range as not being vulcanized until the temperature thereof reaches the predetermined preheating temperature.

Firstly, one embodiment of a device to realize the present invention is described below in detail with reference to the drawings.

In Fig.2, a turn table 2 which rotates during heating is provided in a heating chamber 1, and a green tire 3 is set with its axis along vertical direction onto the turn table 2, and UHF radiation horns 4 provided in both sides of the green tire 3 are connected to a UHF generating device 6 via a waveguide 5. A first timer 7, a second timer 8 and a third timer 9 are connected to the generating device 6. The operation of each timer is sequentially linked to each other by limit switches after each preset time. For example, UHF is radiated for a certain time interval after the first timer 7 is operated, and then the second timer 8 is operated to interrupt radiation for a certain time interval, and then the third timer 9 is operated to start radiation for a certain time interval, and then the second timer 8 is operated to interrupt radiation for a certain time interval, and thereafter only the third timer 9 and the second timer 8 are operated alternately to repeat the start and the interrupt of radiation until the predetermined preheating total time is passed.

Next, one embodiment of the present invention is described below in detail using the case of a green tire for example.

Intermittent heating means to repeat alternately the start and the interrupt of UHF radiation with certain amount of output power to a green tire for the predetermined time interval, for example, first to start radiation continuously for five minutes and then to interrupt radiation for five minutes,. Input of necessary and sufficient amount of heat quantity is made possible by way of increasing the internal temperature of the tire up to a certain limit value during each radiation time interval, and of inducing heat conduction during each radiation interrupt time interval. One example of time allotment for the intermittent radiation is shown as below: radiation for 5 minutes (preheating started) – interruption for 5 minutes - radiation for 3 minutes - interruption for 5 minutes - radiation for 3 minutes - interruption for 5 minutes - radiation for 3 minutes - interruption for 5 minutes - radiation for 3 minutes - interruption for 5 minutes - radiation for 3 minutes - interruption for 5 minutes (preheating finished: the predetermined temperature is reached).

The time interval for each intermittent radiation can arbitrarily be set as long as internal temperature of a tire stays under the critical temperature where rubber starts vulcanization reaction, 100 °C for example. If the radiation time interval is excessively long, a tire is much preheated until its internal temperature exceeds the critical temperature so that appropriate vulcanization in the successive process cannot be sustained. However, if excessively short on the contrary, total necessary time for preheating becomes longer to decrease economical merit, and the most desirable radiation time interval is so to be set as the necessary time to increase the temperature slightly below 100 °C for example. As intermittent radiation is progressed, amount of heat conduction decreases and heat quantity is accumulated in the tire, therefore each intermittent radiation time interval theoretically decreases gradually as later as the end of preheating process, but the above mentioned time allotment may be chosen from industrial view point.

Each interruption time interval is necessary time to finish heat conduction for heat quantity which is injected into the internal part of a tire under the condition that the heat radiation therefrom is protected, and is empirically enough for about five minutes for example.

The predetermined preheating temperature T_1 depends on types and sizes of green tires, and necessary time for a green tire of a specific type and of a specific size to reach the predetermined preheating temperature T_1 is estimated as follows. For example, if it takes t_1 minutes to reach the predetermined preheating temperature T_1 in a conventional method where UHF is radiated continuously to preheat, the time allotment of intermittent radiation is chosen as above mentioned embodiment. Multiple of intermittent radiation patterns where each total preheating time, summation of each radiation and interruption time is t_2, t_3, t_4, t_5 etc., are examined one after another to find out a pattern where the actual internal temperature T_2 of a tire at the starting point of vulcanization does not decrease keeping the same value of the predetermined preheating temperature T_1, and then this preheating time pattern becomes necessary time for a specific tire to reach the predetermined preheating temperature. As for the same kind of tires as the specific tire, the same intermittent radiation pattern as the specific pattern can be applied by setting it in the timers of the preheating device.

It is needless to say that in case of the tires which have finished preheating by the present invention being impossible to proceed immediately to next vulcanization process owing to mismatch of process timing, it is necessary to keep the preheated tires in a heated chamber to prevent heat radiation therefrom.

As mentioned above, according to the present invention, optimal vulcanization is so realized that by preheating such non-vulcanized rubber products as green tires with intermittent radiation of such high frequency wave as UHF within such temperature range as not being vulcanized until the temperature thereof reaches the predetermined preheating temperature, preferably slightly below the critical temperature for vulcanization reaction to start, necessary and sufficient amount of heat quantity is injected into the green tires without a danger of over-vulcanization, and that there is no possibility to cause such inconvenience as for the internal temperature thereof at the starting point of vulcanization to become below the apparent temperature at finishing point of preheating.

4. Brief Description of the Drawings

Fig.1 is a schematic diagram of the preheating device to effectuate the present invention. Fig.2 is a diagram showing the internal temperature changes of preheated green tires both by a conventional method and by the present invention from starting point to finishing point of vulcanization. (A solid line shows the case of the present invention and a dotted line for conventional method.)

1: Heating device, 2: Turn table, 3: Green tire, 4: Radiation horns, 5: Waveguides, 6: UHF generating device, 7: First timer, 8: Second timer, 9: Third timer, T_1: Apparent preheated temperature at the finishing point of preheating, T_2: Internal temperature of a tire at the starting point of vulcanization